

LEARNING WITHIN COMMUNITIES OF PRACTICE IN PRESERVICE SECONDARY SCHOOL TEACHERS EDUCATION

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We present the main features of a study that explored the learning processes of a group of preservice mathematics teachers in a methods course. We discuss the implications of using the communities of practice perspective in designing and developing teacher training programs.

Keywords: Teacher learning; Teacher education; Communities of practice; Wenger; Preservice education; Secondary mathematics.

Aprendizaje en la Formación Inicial de Profesores de Educación Secundaria desde la Perspectiva de las Comunidades de Práctica

En este estudio exploramos los procesos de aprendizaje de un grupo de futuros profesores de matemáticas en una asignatura de formación inicial. Discutimos las implicaciones de utilizar la perspectiva de las comunidades de práctica para el diseño y desarrollo de planes de formación de profesores.

Términos clave: Aprendizaje del profesor; Formación de profesores; Comunidades de práctica; Wenger; Formación inicial; Matemáticas de secundaria.

LEARNING IN PRESERVICE MATHEMATICS TEACHER EDUCATION

Teachers neither work, nor learn alone. Teaching and learning to teach are social practices and collaborative enterprises (Secada & Adajian, 1997). That is why research in teacher education has become increasingly concerned with teachers' development from perspectives rooted in sociocultural views of learning (Lerman, 2001; Llinares, 1998). In particular, Wenger's social theory of learning (Wenger, 1998) and its notion of community of practice are becoming popular as a conceptual framework for exploring the learning processes of mathematics teachers working together. However, "while mathematics teacher education researchers are creating contexts that enable teacher learning and describe what

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teachers learn in social terms, little has been done to explain *how* those contexts enable learning” (Graven & Lerman, 2003, p. 189). Furthermore, there has been little research examining the specific interactions and dynamics that happen in those contexts: “One analytic task, therefore, is to show how teachers, in and through their interactions with one another and with the material environment, convey and construct particular representations of practice” (Little, 2002, p. 934). As Krainer (2003) has pointed out, there is much to be explored concerning the role of this perspective in teacher education: “To what extent can an approach like ‘Community of practice’ be applied to learning at schools and universities? What can we learn from ‘learning enterprises’? What implication for research in teacher education has an approach that builds on ‘community of practice’?” (p. 96).

Within the research agenda described by the previous questions, we present and discuss the main features of a study that, in the context of a methods course, explored the learning processes of a group of mathematics preservice teachers working at home. For that purpose, we first describe the methods course, introduce Wenger’s social theory of learning, and portray the methodology used. Then, we present an example of the results obtained, and we argue that the group developed a community of practice. Finally, we discuss the implications of using the community of practice perspective in the design and development of teacher training programs.

PRESERVICE TEACHERS’ LEARNING IN A METHODS COURSE

The study was part of a research project exploring the didactic knowledge development of secondary preservice teachers in a methods course. Preservice teachers were asked to form groups of four to six persons at the beginning of the course. Each group chose a secondary school mathematics topic on which it worked during most of the course. Examples of topics were the quadratic function, sphere, the Pythagorean theorem, and decimal numbers. During the second part of the course (in which the study was conducted) the groups of preservice teachers were asked to sequentially analyze and describe their topic from different points of view. For example, they had first to produce the conceptual structure of their topic, then identify the representation systems that can be used to represent it, and then to perform a phenomenological analysis of it. The groups worked at home solving the tasks. They produced transparencies with the help of which they presented their work to the classroom. In other studies of this research project we explored the results of the work produced by the groups of preservice teachers. These studies allowed us to identify and characterize four stages of didactic knowledge development with which to describe the groups of teachers’ performance over time (Gómez & Rico, 2004). However, a question remained concerning how this didactic knowledge developed in the groups. Those studies

analyzed the results of learning processes performed by each of the groups. But what kind of processes were there? Is it possible to describe and characterize some of those processes? In other words, is it possible to explore the emergence of learning that took place in a group? Can this exploration help explain the didactic knowledge development of that group? For this purpose, we chose one of the groups of preservice teachers and asked their members to allow us to record in audio their group interaction while preparing their presentations for the course. This group had the quadratic function as its topic of study. Eight meetings were recorded, producing 18 hours of recording.

We had then to approach a theoretical and methodological problem. How to explore, describe and characterize the learning of a group? Following Stein & Brown (1997) we decided that “rather than focusing on the learning processes of individual teachers undergoing transformation, [we could conceptualize] teacher learning as a process of ‘transformation of participation’ in the practices of a community” (p. 155). For that purpose, we decided to ground our study on Wenger’s social theory of learning (Wenger, 1998).

LEARNING AS A SOCIAL PRACTICE

Wenger’s social theory of learning is based on four notions: meaning, practice, community and identity. He introduces *meaning* as a way of talking about our (changing) ability —individually and collectively— to experience our life and the world as meaningful. The negotiation of meaning emerges from the interaction of two processes: *participation*, as the process in which we establish relationships with other people, we define our way to belong to the communities in which we engage on some enterprises, and we develop our identity; *reification*, as the process of giving form to our experience by producing objects that congeal this experience into “thingness”. Every community produces its abstractions, tools, symbols, stories, terms and concepts that reify some of the practice in congealed form. The notion of *practice* is presented as a way of talking about the shared historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action. Practice is the source of coherence of the communities and the process through which we experience the world meaningfully. It does not exist in abstract; it exists because people engage in actions whose meanings are negotiated. The idea of *community of practice* represents the smallest unit of analysis in which one can include the negotiation of meaning as mechanism of learning. It is a way of talking about the social configurations in which our enterprises are defined as worth pursuing and our participation is recognizable as competence. The idea of community of practice is configured on three notions: mutual engagement, joint enterprise and shared repertoire. Finally, the notion of *identity* is introduced as a way of talking about how learning changes who we are and creates personal histories of becoming in the context of our

our communities. Learning as a social practice can be characterized by the three notions configuring the idea of community of practice: *learning in practice implies a mutual engagement in the search of a joint enterprise with a shared repertoire*. That is, learning in practice implies:

- ◆ *Evolving forms of mutual engagement*: how to engage, what helps and what bothers, developing mutual relations, defining identities, establishing who is who, who is good at what, who knows what.
- ◆ *Understanding and tuning the enterprise*: aligning the engagement, accountability and responsibilities, defining and interpreting the enterprise.
- ◆ *Developing the repertoire*: renegotiating meanings, producing and adopting tools, artefacts and representations, recording and recalling events, inventing and redefining terms, telling stories, creating and breaking routines.

LEARNING AS A SOCIAL PRACTICE IN PRESERVICE TEACHER TRAINING

Figure 1 presents a diagram of the methodological procedure that we used to operationalize Wenger's social theory of learning in order to study the quadratic function group's work. We decided to focus our attention on the three processes implied by learning in a community of practice: evolving forms of mutual engagement, understanding and tuning the enterprise, and developing the shared repertoire. These are the three *categories* of analysis. Based on the description that the theory makes of these processes and the specificity of our research context, we characterized each category in *aspects* and for each aspect we produced a set of questions, that we called *themes*. For example, the mutual engagement category was organized in four aspects: the role of the environment (what helps, what bothers), the building of identities, the evolution of relationships among the members, and the processes of negotiation of meaning. Concerning the processes of negotiation of meaning, we identified five themes: the production of meaning proposals, the adoption of meaning proposals, meaning difficulties, discovery of meaning and reification. In the case of the theme meaning difficulties we produced two *codes*: events of confusion of meaning, and events of conflict of meaning. On the basis of this procedure for interpreting the theory and contextualizing it to a research context, we produced a first version of the codes set. This codes set was revised during a first partial coding of the transcriptions. The result was a set of 94 codes. For example, we assigned the code *teaching experience* to those episodes in which at least one participant refers to his/her experience as a teacher.

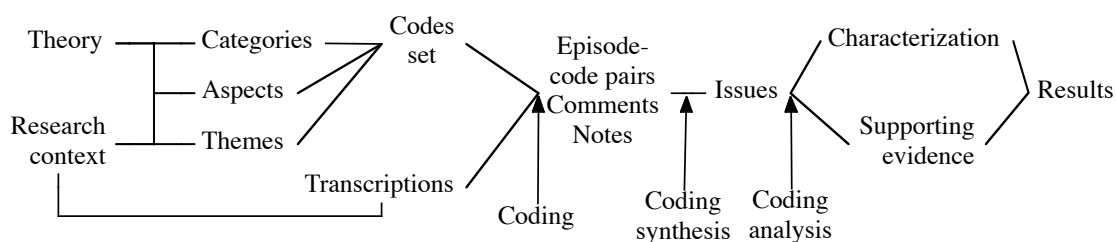


Figure 1. *Operationalizing Wenger's social theory of learning*

We coded the transcriptions, producing 7,412 episodes —code pairs corresponding to 2,606 episodes (since several codes could be assigned to a given episode). For each episode, we produced a comment, in which we described what the content of the discussion in that episode was about. Furthermore, parallel to the coding process, we produced a series of notes in which we registered aspects of the interaction that either could not be characterized by the codes or went farther than what the coding allowed us to register. This coding process produced a huge amount of very detailed information. Through a process of *coding synthesis* we identified the main *issues* concerning the learning of the group that appeared in the coded transcriptions. Finally, through a process of *coding analysis* we were able to establish the main characteristics of each issue and identify the episodes that were more representative of each characteristic. Our approach was similar to the one used by Little (2002). We also shared with her work the purpose of such a fine-grained procedure: “to produce well-grounded assertions regarding social practice and learning” (p. 920).

NEGOTIATION OF MEANING: CONFUSION

We present here a glimpse of one of the results of the study. It concerns confusion of meaning. This is one of the several issues we found in relation to negotiation of meaning in the group. We characterized the episodes of confusion of meaning as those in which, for a particular question, one or more of the participants: are not sure about its meaning, change their opinions about its meaning across the meetings, or make meaning proposals that are not valid.

The difference between the notions of equation and function was in the centre of a confusion of meaning that spanned during several meetings. While working on the history of their topic, the group got interested in the relation between those two notions and some of its members engaged themselves in a historical exploration, with the hope of solving the issue. However, the confusion reappeared while working on the mistakes and difficulties that the students in school might have with their topic. The confusion remained for some time. However, in the last meeting we found evidence showing that it had been resolved.

The following episode belongs to the meeting in which the group worked on the history of their topic. One of the participants thinks that he knows the difference between the notions of equation and function. However, the confusion ap-

pears when the group tries to establish such a difference. They start by stating that the quadratic function is the generalization of the quadratic equation and they finish with an emphatic claim: every quadratic equation is a function. This meaning is adopted by the group and is reified in the transparency produced in this meeting:

P3: What I mean... I am going to say it: we know very clearly what an equation and a function are, because... What can I tell you... Perhaps because for the last 30 years a difference has been established, and that is what we have been taught.

P2: OK, but you are not going to explain that.

P3: No, no. I agree. Wait, what I want to say is... I am not talking about us. Why all this mess? Because we think in a certain way. Equation and function. That is: function, when is the term function used? When you have to give...

P2: A relation between variables, some magnitudes...

P3: A relation between one variable and another, between a magnitude and another. But the equation was there since the beginning. And equation of second degree, it is simply a question of the change of one thing with respect to the other; with the equation of second degree. That is a function of second degree. Therefore, we are going to talk about equations of second degree, and then we tell them...

...

PX: What happens is that for me, the generalization of an equation of second degree is in fact a function.

P3: OK, it is a function. It can also be that.

PX: No, it is not that it can be, it is.

P3: OK, it is.

PX: And what happens is that any equation of second degree is a function.

PX: But since this is a work on history...

PX: Yes (several participants talk simultaneously).

In this episode², we can see some aspects of a process of negotiation of meaning within the group. Firstly, there is confusion concerning the meaning of the notions of equation and function, and the difference between them. This confusion is made explicit due to the fact that they are looking at the history of their topic.

² Transcriptions have been translated from the original Spanish version.

But there is also confusion because the group adopts a meaning of the two notions that is not valid with respect to established mathematical knowledge: “the generalization of an equation is in fact a function”. Secondly, we see participation. At least three of the four members of the group participate in the discussion and make comments and proposals. The members of the group have become used to ask questions and to expect reactions from the other participants: “when is the term function used?”. This can be interpreted as one of the ways through which members care for each other’s learning. Thirdly, there is conflict. One of the participants, PX, has an idea and puts it forward. Another participant, P3, interprets this proposal: “OK, it is a function. It can also be that”. But this was not the meaning proposed originally by PX. He emphatically corrects this interpretation, without further arguments: “No, it is not that it can be, it is”. This is one of the mechanisms of conflict resolution: a proposal without arguments that is accepted by the group. Fourthly, a member makes a reference to their mathematical preparation in their career. Finally, there is reification. The group adopted this proposal and it was reified in the transparency that they presented to the class.

THE EMERGENCE OF A COMMUNITY OF PRACTICE

The above example of an episode gives a glimpse of the behaviour of the group as a community of practice. In particular, it shows instances of some of the features of their processes of negotiation of meaning. However, confusion of meaning is only one of the thirty relevant issues we identified and characterized. The structuring of those issues and the evidence supporting them enabled us to produce an account of the working of the group as a community of practice. We do not have space here to present such an account. What follows describe, as an example, some of those issues.

We found that one of the participants had become the leader of the group. We characterized his role as a leader in terms of his forms of participation as well as describing the forms of “complementary participation” shown by others members in relation to the leader’s behaviour. On the other hand, we found three elements related to the group as a community of practice that had clear and specific effects on the processes of negotiation of meaning within the community. First, most of the members had some teaching experience. As matter of fact it is clear that the leader was accepted as such because he had what was seen as the most thorough of teaching experiences. But all members recalled their teaching experience and constructed stories based on it in order to make proposals of meaning, and to put forward arguments supporting those proposals. Second, even though the trainers gave a list of bibliographic references concerning mathematics education literature, the group did not mention any of those references. On the other hand, textbooks played an important role in their discussions. They used information in textbooks for resolving some of their confusions and conflicts of mean-

ing. Furthermore, their use of textbooks was central in the design of the activities that shaped their proposal for a didactic unit. Finally, one of the trainers handed in written commentaries to the presentations made and transparencies produced by each group. Even though the group did not take into account these commentaries in every meeting, they were a significant factor in the group's working, while producing the final document. It was at this moment when, by reviewing the commentaries, the participants were able to resolve some of the most resilient confusions and conflicts. Although there are references in the transcriptions to what happened in the classroom (interaction with peers, spoken commentaries from the trainers to their presentations, or general statements of the trainers), we found that the commentaries to the transparencies were the most important link between the working of the group and the classroom environment. In Wenger's terminology this was the most important *boundary object* (Wenger, 1998, p. 104) between the group as a community of practice and the community of practice of the classroom.

In the episode we presented above we saw that participants cared for each other's opinions and expected arguments supporting them. This type of participation promoted *interdependent learning*, one of the most important features of a community of practice. This process of search of meaning generated events of confusion, conflict and discovery. We characterized the mechanisms used for these types of events. Given that the group had to solve a task in each meeting, these processes of negotiation of meaning always ended in the adoption of some proposals that were reified and registered in the transparencies. These were some of the objects of reification of the group and served as reference for their discussions later on.

COMMUNITIES OF PRACTICE: A CONCEPTUAL TOOL TO SEE, THINK AND ACT³

Wenger's social theory of learning enabled us to "see" through the complexity of 18 hours of recordings. On the basis of some aspects of this theory, we were able to systematically construct conceptual categories and design instruments for coding and analyzing the information in such a way that we could, at the same time, explore the data in detail, and synthesize and analyze the results of that exploration. We identified and characterized a series of issues that give an account of learning as a social practice in the group.

³ "A theoretical discourse is not an abstraction. It is a set of conceptual tools that enable us to see, think, and act in new ways" (Wenger, 2004, p. 2).

A Tool to “See” and “Think”

We are not suggesting that all groups established themselves as communities of practice or developed learning processes as those depicted by the group we studied. For example, we have evidence of groups in which a leader did not emerge. On the other hand, the analysis of the classroom interaction and of the final documents that we performed in another study suggests that some groups organized themselves as teams: the tasks were divided into subtasks, each member taking responsibility for delivering his/her part. The presentation is then built as the summing of the parts. As Anderson & Speck (1998) have shown, when a group organizes itself as a team, there is learning. However, one cannot expect negotiation of meaning and interdependent learning as properties of the learning processes of a team. What was important in the case of the quadratic function group we studied was the mutual engagement of the participants in the search of a joint enterprise that involved the concern for the learning of all the members of the group. It is not a question of collaboration *versus* cooperation (see, for example, Beck & Kosnik, 2001; Peter-Koop, Santos-Wagner, & Green, 2003). We think that, in contrast with the community of practice perspective, the collaboration approach neither takes into account the complexity of the interactions, nor proposes an overall conceptual structure for describing and analyzing the learning processes involving negotiation of meaning.

The working of the groups is *one* of the contexts in which learning takes place in our methods course. Preservice teachers, individually and collectively, also learn, during the lessons, while doing individual work, in other courses, and while giving private lessons. However, given that the formal assessment that we do of our students gives a high relevance to the presentations of the groups and the documents submitted by them, and that those presentations and documents are produced as a result of the working of the groups, it is now clear to us that we have been specially valuing the learning processes that take place while the groups work at home. Since teaching takes place during the lessons, one tends naturally to think that most learning happens within that context. This study has shown us that this is not necessarily the case.

A Tool to “Act”

The previous paragraphs show how the notion of community of practice has allowed us to “think” about some aspects of our methods course. These thoughts suggest some ideas about how to “act” in the future. Wenger (1998) mentions the risks of romanticizing communities of practice (p. 132). Nevertheless, research on teacher education is giving increasing importance to communities of practice as prominent loci of learning and development in teacher training. For instance, communities of practice can enhance the learning capability of preservice teachers (Knight, 2002, p. 240; Wood & Berry, 2003, p. 65), develop the awareness of the value of collaboration (Beck & Kosnik, 2001, p. 925), help counterbalance the long apprenticeship preservice teachers have had in transmission pedagogy

(p. 945), and encourage the building of professional communities in the future (Lachance & Confrey, 2003, p. 38). If we, as trainers, value the learning that takes place when a group works as a community of practice, how to promote and cultivate such a setting? Answering this question requires that teachers' trainers, besides taking care of *what* they expect preservice teachers to be able to do and to know, get concerned about *how* preservice teachers learn and *what* kind of *teaching* is coherent with that learning. The design of the training program (in particular, issues as the methodology and the trainers' performance and attitudes) can make a difference in that learning. Next, we consider three of those issues. They are examples of the type of questions that should be considered while designing a methods course in which communities of practice and interdependent learning are expected to take place. They refer to the trainers' written commentaries to the groups' work, the definition of the tasks, and the groups' tutoring.

One of the most relevant issues emerging from our study was the characterization of the role that the commentaries to the transparencies played in the processes of negotiation of meaning of the group. The commentaries to the transparencies emerged as the main reference to the socially defined competence of the classroom community. Instead of giving the solutions to the problems observed, the commentaries proposed new questions and opened new spaces for discussion and reflection. In this sense, the commentaries to the transparencies promoted and guided new processes of negotiation of meaning and enhanced interdependent learning within the group.

Another aspect of the design of the course that had an influence on the processes of negotiation of meaning of the groups was the way the tasks were defined and proposed. Preservice teachers expected clearly defined tasks in which they "knew what they were expected to do". However, the tasks usually proposed a general problem (the analysis of the group's topic —e.g., quadratic function— with a given conceptual tool —e.g., materials and resources—) that each group had to contextualize and solve according to their own topic, their previous knowledge and experience, the information they could collect and the shared repertoire that they had developed in the previous meetings. The tasks were proposed in such a way that there was always a challenge involved, but solving them was not seen as impossible by the groups. In this sense, the tasks promoted interdependent learning.

The design of the tasks and the commentaries to the work produced by the groups might promote interdependent learning in a group *if they have already constituted a community of practice*. Otherwise, in a group working like a team, the commentaries to the transparencies and the definition of the tasks are usually interpreted within the working routines already established and do not necessarily promote the negotiation of meaning. If we value the learning that takes place when a group works as a community of practice, how to promote and cultivate such a setting? Answering this question would require, in our case, a change of attitude as teachers' trainers. While interacting with the groups (in the classroom

or in tutoring meetings) we focused our attention on *what* the groups had learned and tried to help them in improving their work (transparencies, presentations and documents). However, we know now that we have also to take into account the *learning processes* that give rise to the productions of the groups and to look for ways of promoting interdependent learning and negotiation of meaning in the groups.

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